# LAr Hand Scan Status

LArSoft Meeting

Oct. 26, 2011

J. Raaf

*with*

C. James, B. Lundberg, S. Moed Sher,
G. Rameika, B. Rebel, A. Szelc, S. Zeller

# Current LBNE LAr Inputs

From LAr case study

| channel | range | value chosen for LBNE sensitivities |
|---|---|---|
| $\nu_e$ CC efficiency | 80-95% | 80% |
| $\nu_\mu$ NC $\pi^0$ surviving fraction | 0.2-0.5% | 1% |
| $\nu_\mu$ CC mis-identification rate | 0-0.3% | 1% |
| other channels | 0% | 0% |
| electron energy resolution | $3\%/\sqrt{E(GeV)}$ | $15\%/\sqrt{E(GeV)}$ |
| muon energy resolution | $10-20\%/\sqrt{E(GeV)}$ | $20\%/\sqrt{E(GeV)}$ (for $E_\nu$) |

Table 4–3: Estimated or measured range of efficiencies, backgrounds, and resolutions from the studies described above (middle column) and the value chosen for the LBNE neutrino oscillation sensitivity calculations described in Section 5.2 (last column).

- Energy-independent $\nu_e$ CC signal efficiency
  - QE + nQE not separated
- NC and $\nu_\mu$ CC mis-ID conservative guesses

- ~~Energy resolutions based on ICARUS~~
- ~~NC smearing matrix directly from WC~~

Not discussed today.

# Hand-Scan Goals

Provide more realistic inputs to GLoBES for LAr sensitivity studies.

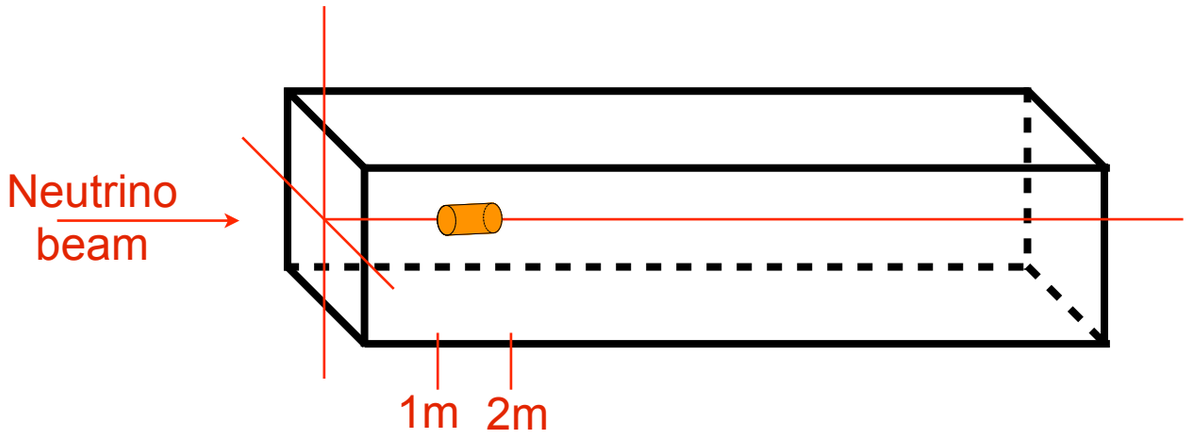
- Energy-dependent $\nu_e$ CC signal efficiency
  - Separate QE and nQE
- Energy-dependent NC mis-ID
- Energy-dependent $\nu_\mu$ CC mis-ID

- Smearing matrices ($E_{true}$ vs. $E_{vis}$)
  - QE
  - nQE
  - NC
  - $\nu_\mu$ CC

**Caveat:**
Taking baby steps!
Many things in this study are not yet fully realistic, but we're moving in the right direction.

# Event Sample (and what aspects are not realistic)

Generated equal mixture of $\nu_e$, $\nu_\mu$, & NC events with GENIE, then simulated in MicroBooNE detector.




Events generated in 10 cm radius cylinder, ranging 1-2 m in from upstream face of detector.

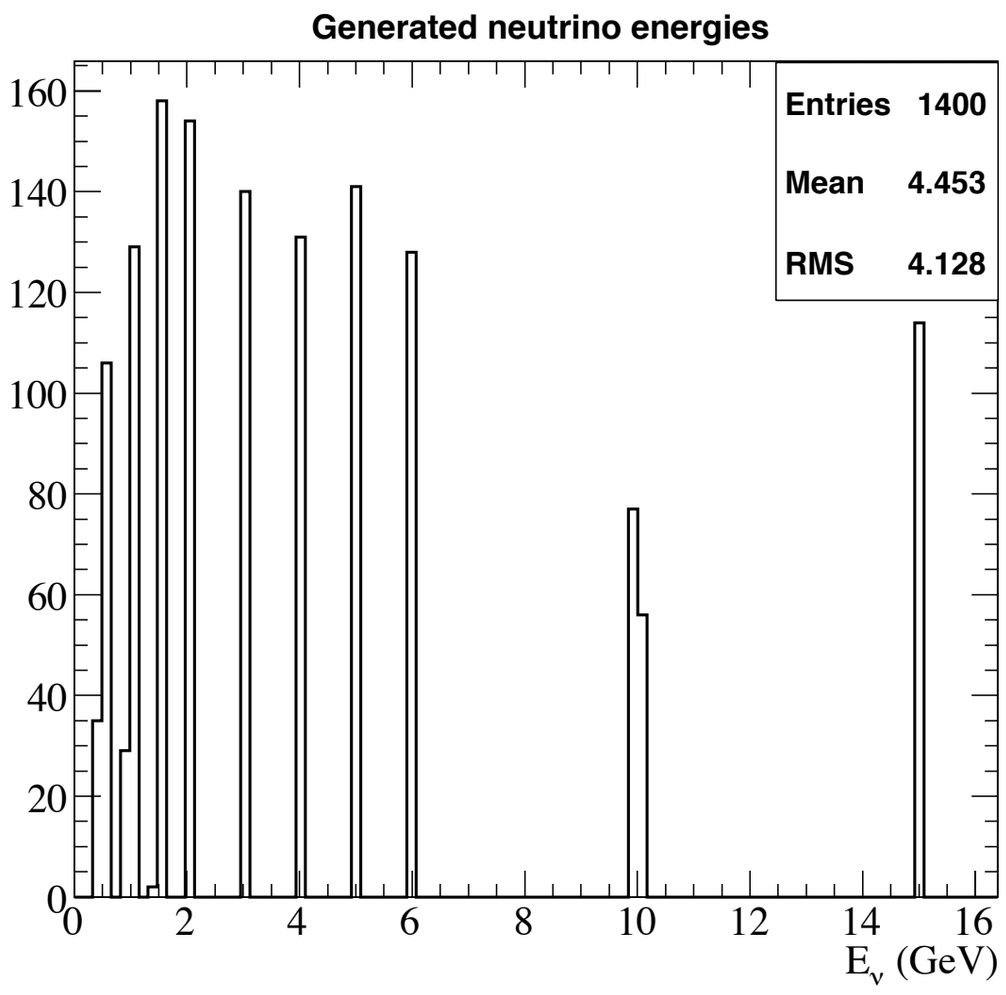
## What is not yet realistic (for LBNE)...

- MicroBooNE geometry (3 mm wire pitch & plane spacing)
  - LBNE design has 5 mm pitch and spacing
- No electronics noise
- Events not generated throughout fiducial volume
- No event reconstruction yet & no dE/dx information
- No study of anti-neutrino events yet

# Scanner Training

Total ~18 hours of group training spanning 3 weeks.
Each potential scanner trained independently as well.

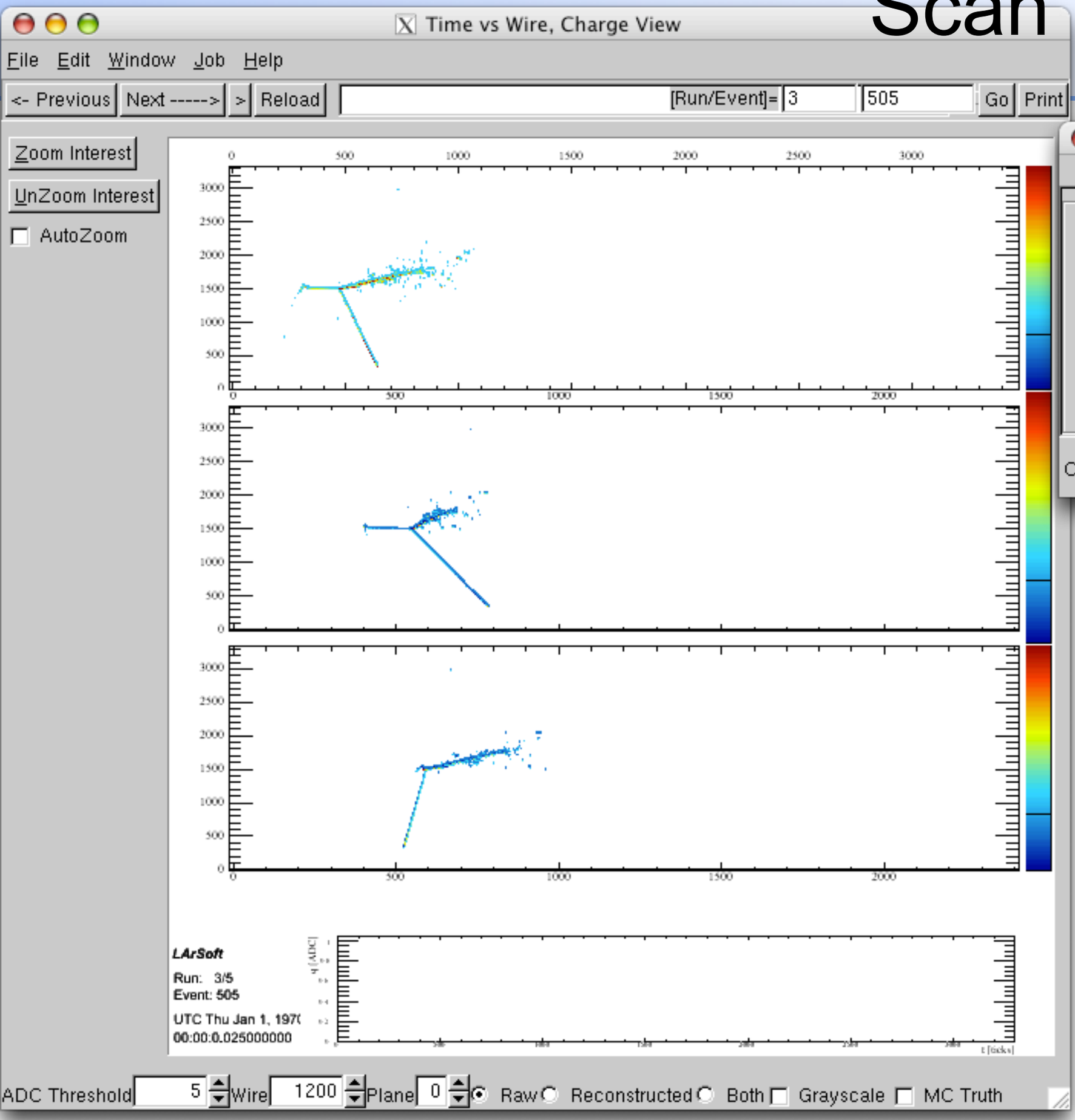
Generated mixture of $\nu_e$, $\nu_\mu$, & NC events at 10 energies
(~equal statistics for each category and neutrino energy)

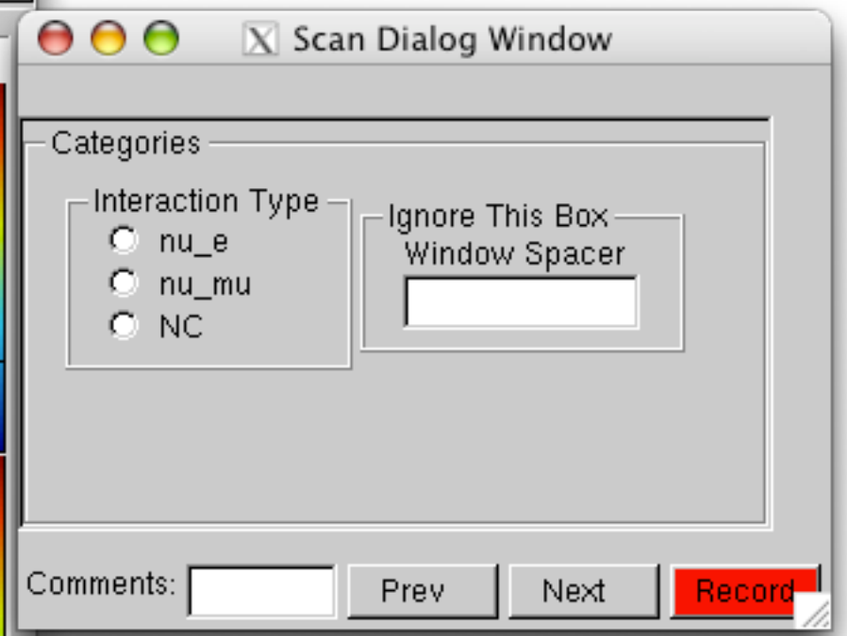



Training sessions showed us that high energy NC events are important:

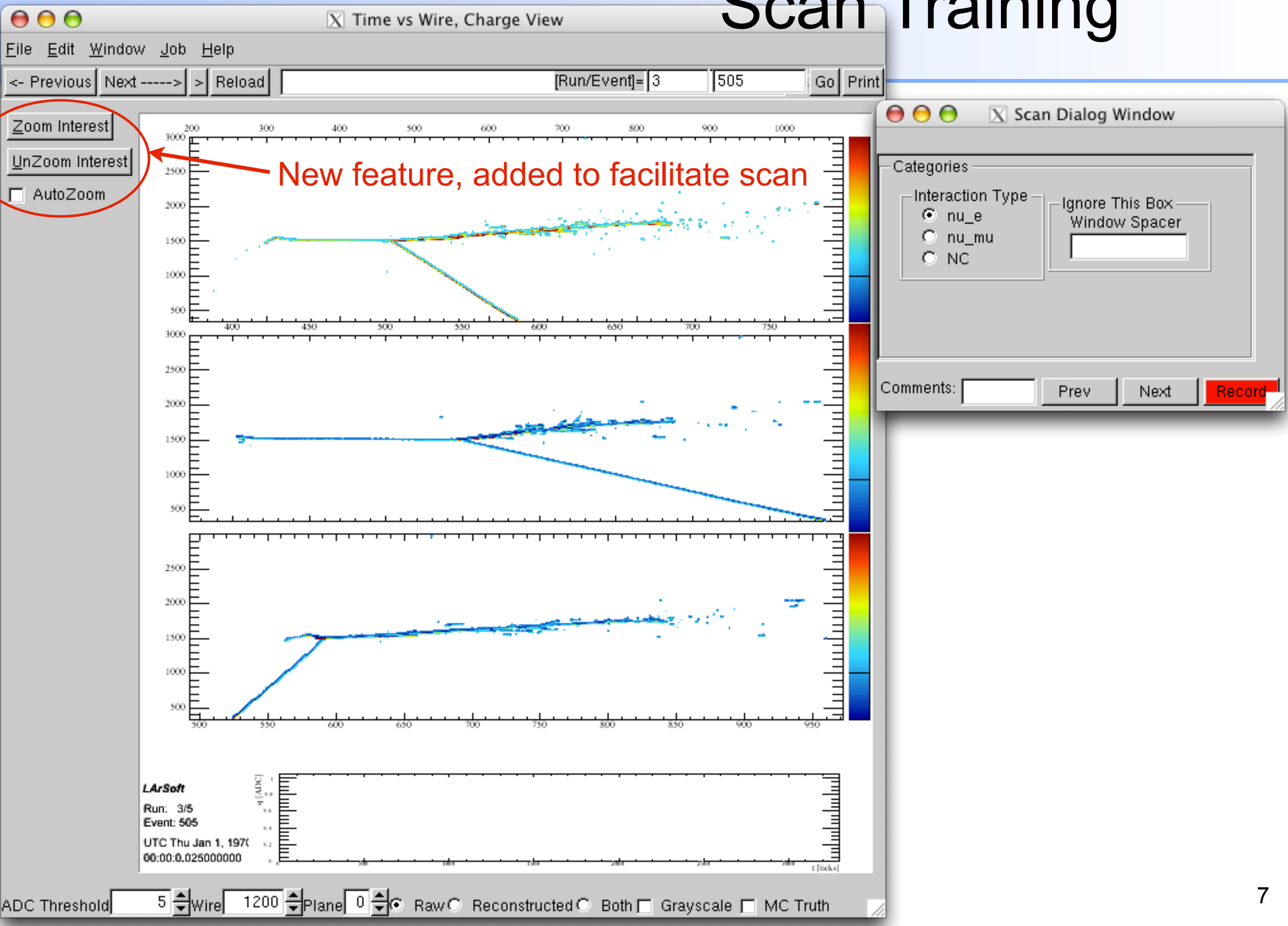
- NC events in tail of LBNE flux often produce events with lower visible energy in detector.

# Scan Training

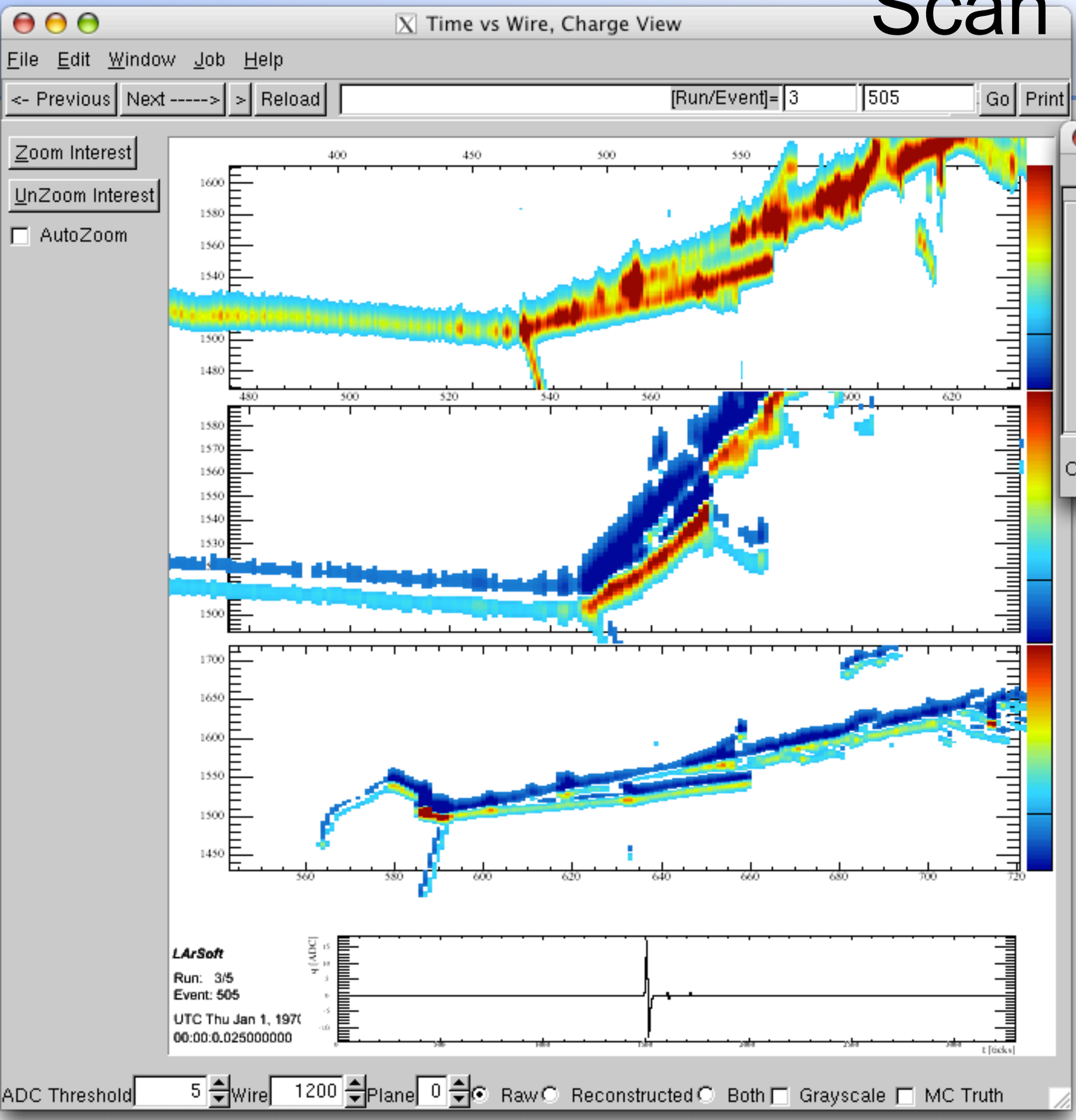


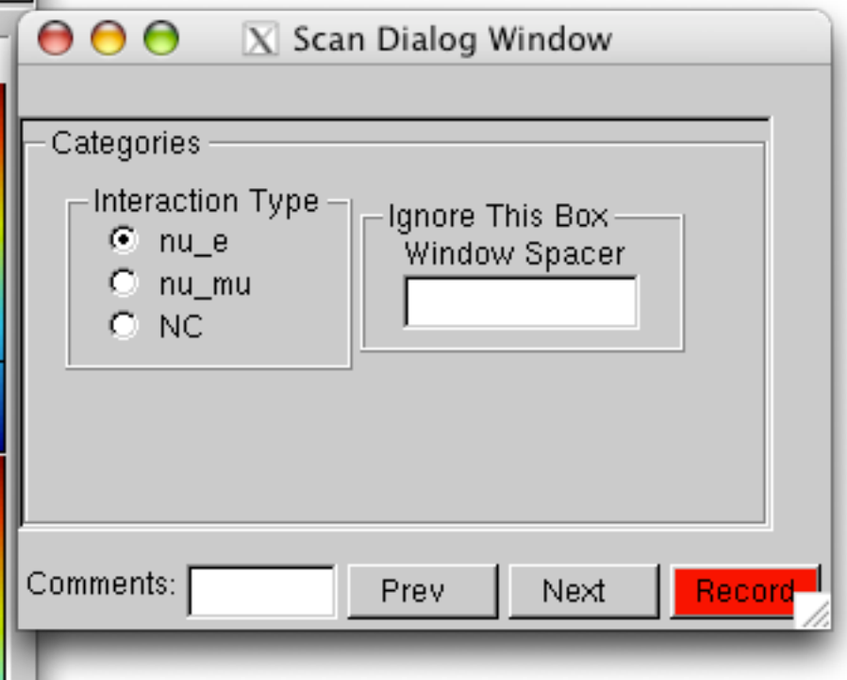



# Scan Training



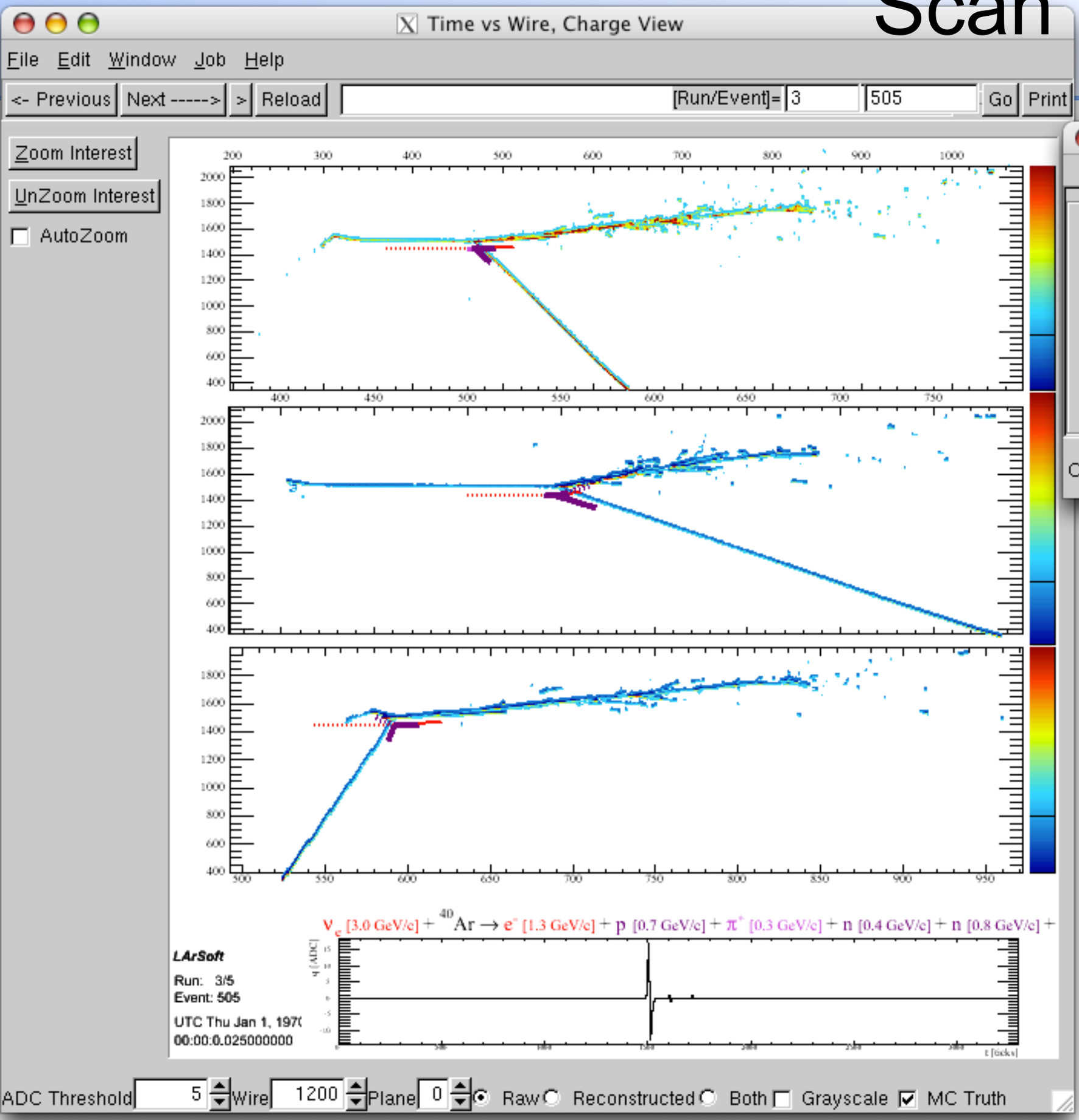
# Scan Training

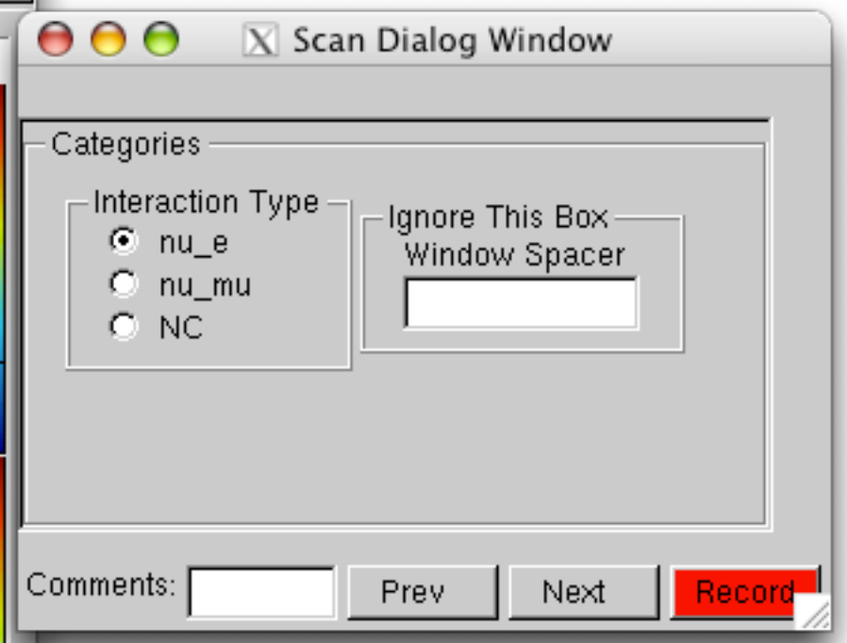



Zooming in to study vertex is very helpful!

# Scan Training




After group reached consensus, looked at MC truth information to see where (if) we went wrong.

Learn from mistakes, move on to next...

# Scanning Qualification Round

Potential scanners were required to independently scan 100 events (mixture of $\nu_e$, $\nu_\mu$, & NC) and obtain a score of >80% correctly ID'ed overall.

Qualification round completed Oct. 7th.

7 scanners.  All passed.

Average overall efficiency 82%.
Average $\nu_e$ CC signal efficiency 86%

# Real Scan

2000 mixed events ($\nu_e$, $\nu_\mu$, & NC) generated in sets of 100.

Each scanner was asked to scan at least 400 events
(but of course could do more if so inclined!)

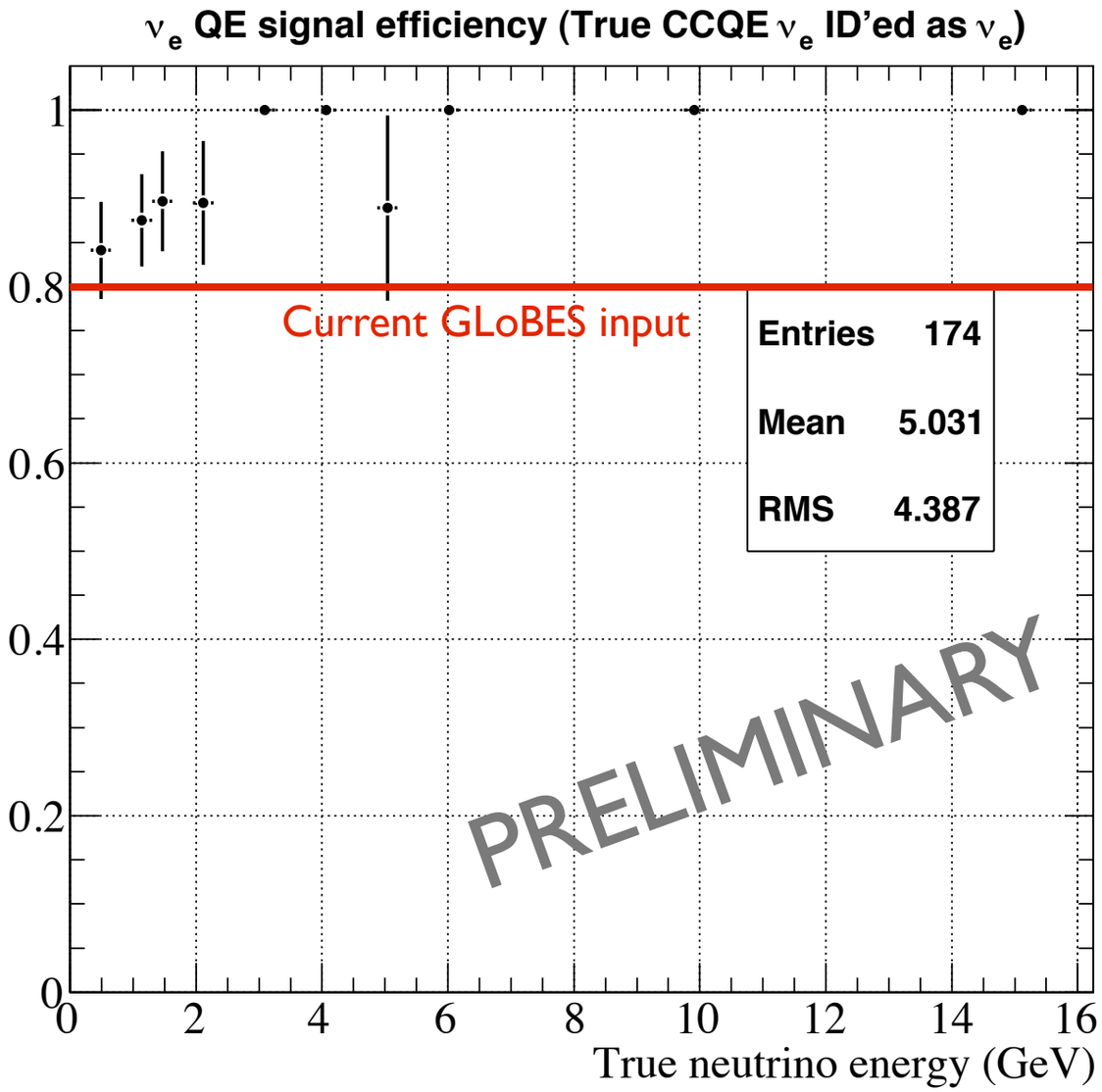
- 200+ events: independent (by single scanner)
- 200 events: overlap (by all scanners, but each scanned alone)

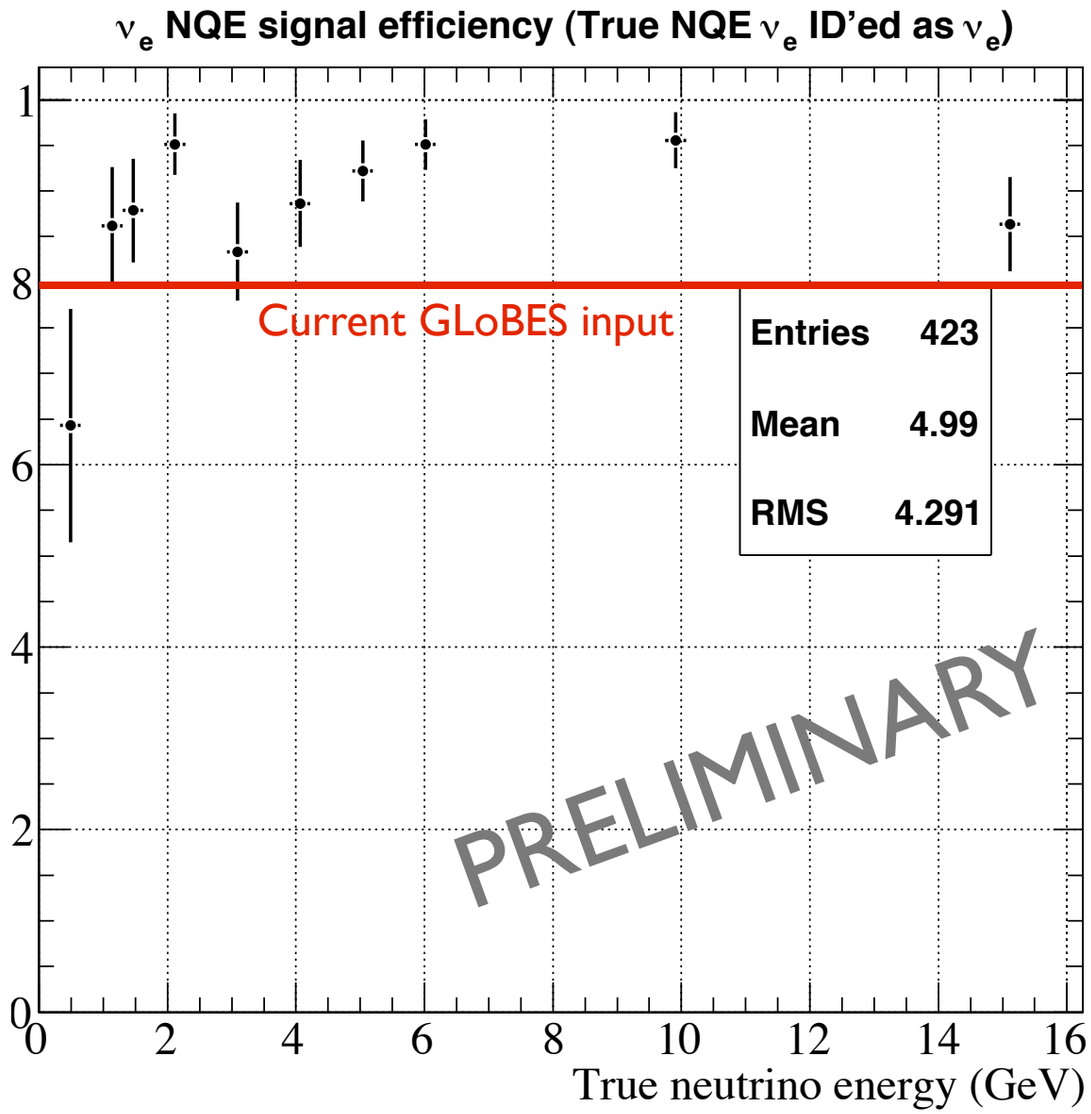
Scanner results mostly in by Oct.16th.
Results being analyzed now, but found that we still need higher statistics.

Further scanning in progress.

# Deliverables from real scan

- Energy-dependent $\nu_e$ QE CC signal efficiency
- Energy-dependent $\nu_e$ nQE CC signal efficiency
- Energy-dependent NC mis-ID
- Energy-dependent $\nu_\mu$ CC mis-ID



# What's Next

Gather more stats & analyze combined results from hand scans.

"Overlap" events will show how scanners compare directly, to determine spread in scanning efficiencies at each energy.

# Other Plans

Investigate efficiency change in moving from 3mm wire pitch and plane spacing (MicroBooNE) to 5mm (LBNE).

Efficiencies for anti-neutrino events.

Check how noise affects scanning results.

# Extra

# Smearing Matrices

Independently from the hand scan, Gina has been generating samples of events ($\nu_e$, $\nu_\mu$, & NC) that can be used to make our first attempt at smearing matrices.

Calculate an effective visible energy by summing the energy of any outgoing particles that would leave energy in the detector:

electrons, gammas, pions, kaons, protons, muons
(ignoring less common “weird” particles (lambda, etc.) for the moment)

Then make matrices of “$E_{vis}$” vs. “$E_{true}$” for each of the categories (QE, nQE, NC, $\nu_\mu$ CC).